APPENDIX N

Proposed Geographic Subdivisions and Archived Reanalysis Results for the Coeur d’Alene Basin Human Health Risk Assessment

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This appendix contains the technical memorandum of the proposed geographic residential subdivisions for the Coeur d'Alene Basin (CDAB) Human Health Risk Assessment that was completed in February 2000. This memo identifies the data sets that support the baseline HHRA, evaluates whether the results of the various surveys can be combined for aggregate analysis, and proposes specific geographic subareas for exposure point concentration and risk estimates. Geographic subareas were selected to appropriately characterize the variation in exposures and risk within the CDAB, while avoiding unnecessary duplication, and protecting confidential health and private property data.

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MEMORANDUM

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Date: February 3, 2000

Subject: Proposed Geographic Subdivisions and Archived Reanalysis Results for the Coeur d'Alene Basin Human Health Risk Assessment

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SECTION 1.0 BACKGROUND AND OBJECTIVES

The Coeur d'Alene River Basin (CDARB) in northern Idaho has long been known to be contaminated by historical mining and smelting activity. Public health investigations in the 1970s to 1980s resulted in the designation of a 21 square mile area called the Bunker Hill Superfund Site (BHSS), or "the box", surrounding the former ore refining complex near Kellogg. Recently, the United States Environmental Protection Agency (USEPA) proposed that the original "box" be extended to include the larger area of contaminant release. This expansion resulted from the review of previous studies indicating areas outside of the original site boundaries present a potential threat to human health and the environment. A Remedial Investigation and Feasibility Study (RI/FS) is being undertaken to characterize the degree and extent of the contaminant release. Concurrently, lead health surveys and a Human Health Risk Assessment (HHRA) are being conducted to determine potential health risks associated with residual contamination in the CDARB.

As part of the HHRA effort, existing health and environmental data have been evaluated for use in characterizing exposures to residents in the CDARB. Data from several basic surveys are, or will be, available to characterize exposures. These studies include a large residential sampling effort undertaken in the summer of 1996 by the Idaho Department of Health and Welfare (IDHW) and the Agency for Toxic Substances and Disease Registry (ATSDR) (IDHW1999), three lead health surveys conducted by the local Panhandle Health District (PHD), three residential USEPA surveys accomplished in the RI/FS (USEPA 1998a, 1998b, and 1998c), the RI/FS, and special studies conducted in the Natural Resources Damage Assessment (NRDA).

The IDHW/ATSDR study (IDHW1999) characterized both environmental contamination and biological indices of human exposure within the basin. During this study, data from 843 residential homes were systematically obtained within the CDARB. Within the scope of the current RI/FS, three additional residential studies have been conducted by the USEPA. These sampling efforts are referred to by Field Sampling Plan Addendum number and are known as FSPA06, FSPA07, and FSPA12 (USEPA 1998a, 1998b, and 1998c). A total of 123 homes within the CDARB were sampled as a result of these efforts. Various environmental data have been obtained from these homes on a voluntary self-identified basis within the past two years.

Additionally, the IDHW and the PHD have conducted fixed site blood lead screening in Upper and Lower Basin CDARB communities over the last three years. A total of 524 children aged 9 months to 9 years have provided venous blood lead samples. These children reside in a total of 260 homes within the CDARB. These homes have been identified and follow-up environmental sampling services have been offered to the parent or home-owner. A total of 128 of these homes were sampled as part of the previous studies discussed above. Of the 132 homes that were not included in previous efforts, 91 of those have been sampled in a special Fall 1999 survey. These data will be available for the HHRA, as well.

In addition, the RI/FS and the associated NRDA activities have conducted various surveys and investigations that can provide information regarding media and tissue contaminant concentrations and active and potential pathways for the HHRA.

The CDARB HHRA will characterize human health risk based on residential exposure, augmented by recreational and occupational exposures outside the home. Due to the large area of concern within the CDARB, it is appropriate to evaluate risk within geographic sub-areas (USEPA 1989). This would serve to avoid both the underestimation of human health risk in areas of the CDARB with significant contamination, as well as the overestimation of risk in areas with little contamination.

The purpose of this memorandum is to identify those data sets that will support the baseline HHRA, to evaluate whether the results of the various surveys can be combined for aggregate analysis, and to propose specific geographic sub-areas for exposure point concentration and risk estimates. Key aspects in the process of evaluating specific geographic sub-areas include identifying sufficient sub-areas to appropriately characterize the variation in exposures and risk within the CDARB, while avoiding unnecessary duplication, and protecting confidential health and private property data.

SECTION 2.0 IDHW/ATSDR AND RI/FS COMMON HOMES DATA EVALUATION

An initial step in the overall evaluation is to determine whether existing survey datasets (IDHW 1999; USEPA 1998a, 1998b, and 1998c) can be combined for further analysis. Due to the similarities of the FSPA06 and FSPA07 surveys, these data sets were previously combined by the USEPA. The same rationale can be applied to the FSPA12 survey, as it was conducted under nearly identical field sampling and analysis protocols.

However, the 1996 IDHW/ATSDR study was conducted under a different protocol than that used in the three USEPA surveys. These protocols differ in two major aspects, including the sampling methodologies employed and how homes were selected.

To evaluate whether the field sampling and analytical techniques used in the surveys produce similar results, surface soil lead and cadmium concentrations from homes common to both the IDHW/ATSDR and the USEPA surveys were compared. Table 1 shows the results for surface soil samples collected at the 23 homes sampled by both protocols.

Surface soil lead and cadmium concentrations (0-1 inch depth horizon) were selected for comparison. These soils are of significant public health concern because these are most likely to be directly contacted by individuals and may migrate into homes or children's play areas. As a result, surface soil concentrations are most often used to characterize media contaminant levels. A second important factor is that previous studies suggest that surface soil contaminant concentrations vary significantly throughout the CDARB. As a result, it is important to characterize this variable by geographic sub-area.

Both protocols recognized the importance of top horizon surface soils and employed similar sampling and analytical techniques. The USEPA protocols required that four discrete surface soil sub-samples be field composited to provide a single sample representative of a particular area of a home yard. These samples were composited by depth 0-1 inch, 1-6 inches, 6-12 inches and 12-18 inches. From five to seven such composite results were obtained at each home depending on yard size or complexity. The 1996 IDHW/ATSDR study required that a minimum of two to a maximum of ten discrete 0-1 inch depth horizon surface soil samples (based on yard area) be field composited to provide one representative analytical result per home. For comparative purposes, it was necessary to average the results obtained under the USEPA protocols for comparison to the 1996 IDHW/ATSDR data.

Tables 2a and 2b show the results of these comparisons utilizing three basic statistical techniques. Relative percent differences ranged from 1% to 126% and averaged 44% for lead, and ranged from 3% to 66% and averaged 28% for cadmium (Table 1). Pearson's correlation coefficients are 0.51 and 0.61 for lead and cadmium untransformed, respectively, and 0.81 and 0.60 for the respective log-transformed variables (Table 2a).

Definitive single factor parametric analysis of variance (ANOVA) tests between individual means ($\alpha = 0.05$) for both raw and natural log transformed data (arithmetic and geometric means) were also evaluated. The results in Table 2a show no significant differences between mean lead ($p=0.76$ arithmetic and $p=0.78$ geometric) and cadmium ($p=0.82$ arithmetic and $p=0.75$ geometric) surface soil concentrations for common homes sampled by both protocols.

Results for linear regression analysis relating cadmium concentrations in a no intercept format in Table 2b show r^2=0.91 and a coefficient of 1.02 that does not vary significantly from 1.0. The regression relating log concentrations shows an r^2=0.96 and a coefficient of 1.02 for cadmium, and an r^2=0.99 and a coefficient of 1.01 for lead. However, the regression for untransformed lead shows an r^2=0.39 with a coefficient of 0.32, suggesting a much weaker relationship and that the 1996 IDHW/ATSDR lead concentrations are considerably greater than the USEPA survey results. However, much of this effect is related to a single outlier value of 12,884 mg/kg found at one home in IDHW/ATSDR dataset. The USEPA survey found 2938 mg/kg at the same home. Tables 2a and 2b show the various statistics with the home containing this outlier removed. The resulting r^2=0.79 and the coefficient of 1.55 for the untransformed lead concentrations suggest that the USEPA lead results may be somewhat higher than the IDHW/ATSDR survey results. Other statistical results are not significantly affected by the removal of the outlier value.

These results suggest that a strong correlation between the two survey results, but lead concentrations determined by the USEPA protocols may be higher than that observed in IDHW/ATSDR survey. This difference, however, was not apparent for cadmium and the magnitude of the increase is likely not indicative of significant methodological differences between the two protocols with respect to exposure point concentrations and risk calculations for other metals. As a result, it is reasonable to combine surface soil results from the two surveys for additional analysis for metals other than lead.

SECTION 3.0 SELECTION OF GEOGRAPHIC SUB-AREAS

Soil contamination data between the IDHW/ATSDR and USEPA surveys may also differ in another important aspect. There may be selection bias associated with the homes sampled in the USEPA surveys. These homes were self-identified based upon a voluntary call-in basis, whereas the IDHW/ATSDR study homes were selected randomly.

To evaluate whether a selection bias exists, data from all surveys were initially combined and parametric single factor ANOVAs applied to the mean soil concentrations by survey within each of the originally identified 1996 IDHW/ATSDR sub-areas (16 total). These analyses showed an insufficient number of common observations to allow a meaningful comparison. This was because the FSPA06/07 and FSPA12 (USEPA) surveys contain relatively few observations (n = 90 and 33, respectively) compared to the 1996 IDHW/ATSDR survey (n = 843). As a result, it was necessary to reduce the number of geographic sub-areas in the analysis.

Further reductions in the number of sub-areas required evaluating confidential IDHW/ATSDR and PHD data sets (1996 to present) to determine the geographic distribution of available blood lead information. These data are key to characterizing blood lead absorption response in the CDARB and to supporting any site-specific dose/response investigation that might be accomplished within the HHRA. Key criteria used in sub-area selection using blood lead data were the inclusion within each sub-area of enough data points to properly estimate blood lead concentrations using established protocols (USEPA 1994), as well as protection of data confidentiality. Due to the relatively large number of observations contained within the IDHW/ATSDR survey dataset, these surface soil lead and cadmium concentrations were also evaluated in this initial determination of proposed geographic subdivisions.

From this evaluation, a total of eight specific sub-areas were selected. Table 3 and Figure 1 show the selected sub-areas. Tables 4 and 5 show total blood lead observation statistics for the Basin by geographic sub-area, respectively. Tables 6 and 7 show summary statistics for IDHW/ATSDR surface soil lead and cadmium concentrations. Total blood lead observations by sub-area range from a minimum of 38 (Mullan) to a maximum of 100 (Osburn). Surface soil lead arithmetic mean concentrations range from 412 (Silverton) to 1212 mg/kg (Mullan). Surface soil cadmium arithmetic mean concentrations range from 1.8 (Lower Basin/Cataldo) to 6.2 mg/kg (Osburn). Total IDHW/ATSDR lead and cadmium observations range from 53 (Silverton), to 189 (Osburn).

These comparisons demonstrate that the proposed sub-areas contain sufficient data to properly characterize blood lead concentrations, and protect data confidentiality. Additionally, both the quantity and range of IDHW/ATSDR surface soil results present within each sub-area are sufficient to properly characterize the variation in exposure and risk from these metals within the CDARB. As a result, the existing surveys can be combined in characterizing these sub-areas with respect to exposure point concentrations and risk calculations.

However, several sub-areas are under-represented in the USEPA surveys. Additionally, the potential for selection bias associated with the USEPA surveys should be evaluated. The USEPA surveys provide the only historical soil concentration data for metals other than lead and cadmium. As a result, several sub-areas lack sufficient data to adequately characterize other metals for the HHRA.

SECTION 4.0 EVALUATION OF ARCHIVAL DATA

To remedy this situation, a number of IDHW/ATSDR samples were retrieved from archives and submitted for re-analysis. Two groups were re-analyzed; 24 samples were analyzed at a USEPA Contract Laboratory Program (CLP) laboratory and 65 samples were re-analyzed at a private laboratory under contract with the State of Idaho (State). Of the 89 total samples re-analyzed, 13 were common homes between the IDHW/ATSDR and USEPA surveys. These re-analyzed samples are excluded in the following analyses. Samples were selected to provide a cross-section of contaminant concentrations within each of the select geographic sub-areas. Table 8 shows comparative results for the re-analyses for lead and cadmium. In this case, IDHW/ATSDR refers to the original 1996 IDHW/ATSDR results from the State laboratory. Archive refers to the re-analyzed samples. Comparison of the results show average relative percent differences (RPD) between IDHW/ATSDR and Archive results of 14% for lead and 16% for cadmium for the combined laboratories, 15% for lead and 28% for cadmium for the CLP laboratory, and 13% for lead and 11% cadmium for the State laboratory.

Single factor ANOVA comparing the arithmetic means ($n = 89$) show no significant differences overall for the IDHW/ATSDR versus combined laboratory results ($p=0.7034$ and 0.7533 for lead arithmetic and geometric means, and $p=0.7972$ and 0.9990 for cadmium arithmetic and geometric means, respectively). Regression analyses relating arithmetic concentrations in a no-intercept format show a coefficient value of 0.87 that is not significantly different from 1.0 and an $r^2 = 0.997$ for lead and a coefficient of 1.0 and an $r^2=0.92$ for cadmium. These evaluations suggest that analytical results are reproducible for lead and cadmium, and that it is appropriate to use the new archive results to characterize other metals concentrations in soils for the HHRA. As a result, additional historical soil concentration data for these other metals are available and will be forwarded to EPA contractors for use in determining exposure point concentrations and risk estimates.

However, it is important to determine whether the IDHW/ATSDR/Archive results can appropriately be combined with the USEPA surveys by sub-area as the USEPA homes may exhibit selection bias. Table 9 summarizes results of parametric single factor ANOVAs applied to differences between Archival and USEPA means both within the overall basin and within sub-areas, for each of the seven surface soil contaminants of potential concern (COPCs) currently under consideration in the HHRA. With the exception of antimony, significantly greater overall mean COPC concentrations are associated with the USEPA survey results, suggesting that an *overall site-wide* selection bias may exist between IDHW/ATSDR/Archive and USEPA results. With the exception of both iron in several sub-areas and arsenic, lead, and zinc in the Lower Basin/Cataldo area, this observation is generally not supported by ANOVA results within sub-areas. However, the reduced statistical power of the ANOVA procedure may account for the lack of significant differences within sub-areas (particularly Lower Basin/Cataldo). Due to the significantly greater USEPA iron concentrations within five of eight sub-areas, it is reasonable to conclude that surface soils from homes sampled under the USEPA protocols contain significantly greater amounts of iron.

These results suggest that *overall Basin-wide* COPC concentrations obtained under the USEPA protocols on a voluntary self-identified basis are higher than those observed within the 1996 IDHW/ATSDR archive samples, and that a selection bias may exist with the USEPA results. However, the magnitude of the increase is likely not indicative of significant methodological differences between the two protocols with respect to estimating exposure point concentrations and risk calculations within sub-areas of the HHRA for other metals. As a result, it is reasonable to combine surface soil results from the IDHW/ATSDR/Archive and USEPA surveys for additional analysis. Table 10 shows final combined concentration results for the seven COPC metals by proposed geographic sub-area.

SECTION 5.0 SUMMARY OF PROPOSED GEOGRAPHIC SUBDIVISIONS

The eight residential sub-areas shown in Table 1 and Figure 1 are proposed for use in characterizing both lead and non-lead residential exposure within the CDARB HHRA. Table 10 summarizes the results for the seven COPCs by sub-area. Human health risk within the CDARB will be based primarily upon residential exposure point concentrations developed from this combined data set. Residential exposures will be supplemented by potential recreational and occupational exposure present within each of the five major geographic subdivisions shown in Figure 1. For each city, recreational and occupational exposure will be estimated within the respective major geographic subdivision defined by the Conceptual Site Model (CSM) units where the particular city is located. The residential sub-areas of Wallace, Silverton and Osburn are encompassed in the Side Gulches major geographic sub-division and will have similar recreational and occupational exposure point estimates. This will serve to provide for more appropriate site-specific estimates of total exposure within each of these major geographic subdivisions.

SECTION 6.0 REFERENCES

Idaho Department of Health and Welfare (IDHW), Division of Health. 1999. Coeur d'Alene Basin Environmental Health Exposure Assessment Draft Final Report. May.

URS Greiner, Inc. 1998a. Field Sampling Plan and Quality Assurance Project Plan for the Bunker Hill Basin-Wide RI/FS, Addendum No. 12, Residential Sampling to Support the Human Health Risk Assessment. Prepared for USEPA under Contract No. 68-W9-0054/0031. March.

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USEPA 1994. Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children. Office of Emergency and Remedial Response, Washington D.C.
EPA/540/R-93/081. February.

USEPA 1989. Risk Assessment Guidance for Superfund: Volume I: Human Health Evaluation Manual, Part A. Interim Final. July.

Table 1
Common Homes Comparison Surface Soil Lead and Cadmium Concentrations (0-1" depth horizon, mg/kg)

Home	Lead			Cadmium		
	USEPA Result	IDHW/ATSDR Result	Relative Percent Difference	USEPA Result	IDHW/ATSDR Result	Relative Percent Difference
1	475	533	11.4	6.4	7.9	21.2
2	1300	527	84.6	7.3	3.9	61.4
3	265	262	1.1	2.2	3.4	40.0
4	306	450	38.1	4.0	6.4	46.6
5	992	808	20.4	4.6	3.7	23.2
6	297	488	48.6	3.1	3.6	13.8
7	872	815	6.8	6.7	5.3	24.3
8	558	510	9.0	5.9	4.7	22.6
9	439	509	14.8	4.0	6.1	40.8
10	64	34	63.2	0.3	N/A	N/A
11	3230	993	105.9	7.1	3.6	66.2
12	2973	1632	58.3	5.0	4.0	22.2
13	1263	656	63.2	9.5	6.6	35.9
14	750	765	1.94	5.1	4.0	23.3
15*	2938	12884	126.0	10.0	10.8	8.0
16	3377	1525	75.6	7.8	5.7	32.0
17	490	315	43.4	4.4	3.9	13.1
18	421	400	5.0	4.6	5.0	7.5
19	439	1253	96.3	5.6	5.8	3.0
20	482	692	35.8	4.9	7.1	37.4
21	186	265	34.9	3.8	4.7	21.8
22	405	424	4.7	5.2	4.2	22.5
23	325	155	70.7	2.7	1.9	37.6
Minimum	64	34	1.1	0.3	1.9	3.0
Maximum	3377	12884	126.0	10.0	10.8	66.2
Arithmetic Mean	993	1169	44.3	5.2	5.1	28.4

* The outlier is not included in the analysis of variance.
N/A: result not available

Table 2a
Common Homes Comparison Surface Soil Lead and Cadmium Concentrations (0"-1" depth horizon) Correlation and ANOVA Results

Pearson's Correlation

		Raw Data		Natural Log Transformed Data	
	N	r	p	r	p
Lead	23	0.51	0.0128	0.81	0.0001
Cadmium	22	0.61	0.0027	0.6	0.0031
Data with Outlier Removed					
Lead	22	0.79	0.0001	0.82	0.0001

ANOVA

		Raw Data		Natural Log Transformed Data	
	N	F_{calc}	p	F_{calc}	p
Lead	45	0.09	0.7637	0.08	0.7818
Cadmium	44	0.05	0.8225	0.11	0.7471
Data with Outlier Removed					
Lead	44	2.20	0.1451	0.68	0.4131

Table 2b
Common Homes Comparison Surface Soil Lead and Cadmium Concentrations (0"-1" depth horizon) Linear Regression Results

		Raw Data		Natural Log	
	N	r^2	Coefficient[1]	r^2	Coefficient[1]
Lead	23	0.39	0.32	0.99	1.01
Cadmium	22	0.91	1.02	0.96	1.02
Data with Outlier Removed					
Lead	22	0.79	1.55	0.99	1.02

[1]USEPA data were dependent variables in these analyses.

Table 3
Survey Sub-Areas Included within Proposed HHRA Geographic Sub-Divisions

Proposed Geographic Subdivisions	Proposed Area Name	Areas included in IDHW/ATSDR Database	Areas included in USEPA FSPA06/07 Database	Areas included in USEPA FSPA12 Database
Mullan	Mullan	Mullan	Mullan	Mullan
Burke/Nine Mile	Nine Mile	Burke, Nine Mile	Burke, Gem, Black Cloud, Woodland Park	Burke, Black Cloud, Woodland Park
Wallace	Wallace	Wallace	Wallace	Wallace
Silverton	Silverton	Silverton	Silverton	Silverton
Osburn	Osburn	Osburn	Osburn	Osburn
Side Gulches	Side Gulches	Big Creek, Elk Creek, Montgomery Gulch, Moon Gulch, Nuckols Gulch, Sunny Slopes, Terror Gulch, Two Mile	Elk Creek, Moon Gulch, Nuckols Gulch, Terror Gulch	Nuckols Gulch
Kingston	Kingston	Kingston, Pine Creek	Kingston, Pinehurst	Kingston
Lower Basin/Cataldo	Lower Basin	Lower Basin	Cataldo	Cataldo

Table 4
Proposed Geographic Total Sub-Area Blood Lead Summary Data for Children (1-9 years old)

Area	Number of Observations				Mean	Variance	Standard Deviation	Minimum	Maximum
	Total	≥10µg/dl	≥15µg/dl	≥20µg/dl					
Mullan	38	4	-	-	5.2	7.3	2.7	2	12
Burke/ Nine Mile	76	16	10	3	7.4	26.9	5.2	1	21
Wallace	77	10	4	2	6	21.4	4.6	1	29
Silverton	73	6	3	1	4.9	13.4	3.7	1	23
Osburn	100	4	-	-	4.1	5.7	2.4	1	13
Side Gulches	51	2	1	-	4.3	7.9	2.8	1	16
Kingston	54	6	4	-	4.8	16.3	4.0	1	16
Lower Basin/ Cataldo	55	10	3	-	5.5	19.6	4.4	1	18
Total	**524**	**58**	**25**	**6**	**-**	**-**	**-**	**-**	**-**

Table 5
Annual Blood Lead Summary Data by Proposed Geographic Sub-Area for Children (1-9 years old)

Year	Number of Observations				Mean	Variance	Standard Deviation	Minimum	Maximum
	Total	≥10µg/dl	≥15µg/dl	≥20µg/dl					
Mullan Area									
1996	11	-	-	-	3.7	2.6	1.6	2	7
1997	-	-	-	-	-	-	-	-	-
1998	5	1	-	-	7.6	4.3	2.1	6	11
1999	22	3	-	-	5.3	8.2	2.9	2	12
Total	38	4	-	-	5.2	7.3	2.7	2	12
Burke/Nine Mile Area									
1996	17	6	3	-	8.3	23.9	4.9	1	17
1997	8	3	2	-	8.2	54.8	7.4	2	19
1998	18	4	3	2	7.5	41.0	6.4	2	21
1999	33	3	2	1	6.6	15.9	4.0	1	20
Total	76	16	10	3	7.4	26.9	5.2	1	21
Wallace Area									
1996	14	1	-	-	4.2	7.9	2.8	2	11
1997	1	-	-	-	2	-	-	2	2
1998	28	4	1	-	5.9	12.9	3.6	1	16
1999	34	5	3	2	6.8	33.0	5.8	2	29
Total	77	10	4	2	6	21.4	4.6	1	29
Silverton Area									
1996	14	2	1	-	5.5	14.4	3.8	2	16
1997	5	-	-	-	4.4	6.8	2.6	2	8
1998	26	-	-	-	4.1	3.2	1.8	1	8
1999	28	4	2	1	5.4	23.9	4.9	1	23
Total	73	6	3	1	4.9	13.4	3.7	1	23
Osburn Area									
1996	15	1	-	-	4	8.1	2.9	1	13
1997	7	-	-	-	3.8	3.5	1.9	1	7
1998	22	-	-	-	4	3.7	1.9	1	8
1999	56	3	-	-	4	6.4	2.5	1	11
Total	100	4	-	-	4.1	5.7	2.4	1	13
Side Gulches Area									
1996	8	-	-	-	2.7	1.1	1.0	1	4
1997	-	-	-	-	-	-	-	-	-
1998	12	1	-	-	5	9.7	3.1	3	14
1999	31	1	1	-	4.3	8.4	2.9	1	16
Total	51	2	1	-	4.3	7.9	2.8	1	16

Table 2.1.2
Annual Blood Lead Summary Data by Proposed Geographic Sub-Area for Children (1-9 years old) (continued)

Kingston Area									
	Number of Observations						Standard		
Year	Total	≥10µg/dl	≥15µg/dl	≥20µg/dl	Mean	Variance	Deviation	Minimum	Maximum
1996	7	1	1	-	6.4	22.3	4.7	2	16
1997	-	-	-	-	-	-	-	-	-
1998	8	-	-	-	2.8	3.6	1.9	1	7
1999	39	5	3	-	4.8	17.2	4.2	1	16
Total	54	6	4	-	4.8	16.3	4.0	1	16
Lower Basin/Cataldo Area									
1996	12	4	1	-	5.2	31.1	5.6	1	18
1997	5	1	-	-	5.4	15.8	4.0	2	12
1998	9	1	-	-	3.5	14.0	3.8	1	13
1999	29	4	2	-	6.2	17.6	4.2	1	18
Total	55	10	3	-	5.5	19.6	4.4	1	18

Table 6
Proposed Geographic Sub-Area Soil Lead Summary Statistics
from the 1996 IDHW/ATSDR Exposure Survey

Area	Arithmetic Mean	Geometric Mean	N	Standard Deviation	Minimum	Maximum
Mullan	1212	602	88	2403	41	20218
Burke/Nine Mile	1029	623	70	826	32	3250
Wallace	1024	764	78	799	54	4285
Silverton	412	331	53	300	98	1724
Osburn	727	476	189	1227	43	12884
Side Gulches	486	321	108	542	25	3920
Kingston	823	255	77	1824	22	9228
Lower Basin/Cataldo	455	108	152	1196	15	7350

Table 7
Proposed Geographic Area Soil Cadmium Summary Statistics from the 1996 IDHW/ATSDR Exposure Survey

Area	Arithmetic Mean	Geometric Mean	N	Standard Deviation	Minimum	Maximum
Mullan	3.9	2.7	88	3.6	0.3	16.3
Burke/Nine Mile	4.8	3.3	70	3.6	0.1	21.4
Wallace	5.3	4.6	78	2.7	1.3	14.7
Silverton	4.2	3.4	53	3.5	0.7	24.9
Osburn	6.2	5.4	189	3.6	0.9	21.4
Side Gulches	4.8	3.8	108	2.9	0.3	14.6
Kingston	2.8	1.9	77	3.1	0.1	14.7
Lower Basin/Cataldo	1.8	1	152	2.4	0.1	12.5

Table 8 Comparisons between Original IDHW/ATSDR and Reanalyzed Archived Sample Results

				Lead			Cadmium		
Result	Sub-Area	Laboratory	Common Homes	IDHW/ATSDR 1996 Results	Archive Sample Reanalysis	Relative Percent Difference	IDHW/ATSDR 1996 Results	Archive Sample Reanalysis	Relative Percent Difference
1	KINGSTON	State		157	161	2.3%	2.0	2.5	20.3%
2	LOWER BASIN/CATALDO	State		66	66	0.5%	0.9	0.5	56.1%
3	LOWER BASIN/CATALDO	State		322	334	3.8%	2.5	2.9	14.4%
4	LOWER BASIN/CATALDO	State		199	216	8.3%	1.9	1.9	2.7%
5	KINGSTON	State		226	243	7.2%	2.3	2.2	2.2%
6	KINGSTON	State		145	156	7.5%	1.5	1.7	12.5%
7	LOWER BASIN/CATALDO	State		27	28	3.2%	0.4	0.5	22.2%
8	LOWER BASIN/CATALDO	State		432	439	1.7%	1.7	2.0	14.5%
9	LOWER BASIN/CATALDO	State		134	117	13.7%	1.4	1.5	7.6%
10	LOWER BASIN/CATALDO	State		43	38	13.9%	0.6	0.5	24.6%
11	LOWER BASIN/CATALDO	State		401	326	20.7%	2.5	2.4	2.5%
12	LOWER BASIN/CATALDO	State		175	145	18.6%	2.4	2.3	5.5%
13	MULLAN	State		198	184	7.4%	1.8	2.0	10.5%
14	MULLAN	State		49	47	5.6%	0.5	0.5	0.0%
15	MULLAN	State		696	602	14.4%	2.4	2.7	11.8%
16	MULLAN	State		115	109	5.0%	1.6	1.7	9.2%
17	MULLAN	State		1559	1180	27.7%	6.4	6.1	5.4%
18	MULLAN	State		314	298	5.3%	1.2	1.5	22.2%
19	MULLAN	State		626	548	13.2%	2.8	3.1	10.2%
20	MULLAN	State		2015	1820	10.2%	12.2	12.2	0.0%
21	MULLAN	State		3750	3370	10.7%	12.9	13.4	3.8%
22	MULLAN	State		1095	960	13.1%	5.0	5.2	4.9%
23	MULLAN	State		5437	5140	5.6%	10.7	10.5	1.9%
24	MULLAN	State	x	1632	1180	32.1%	4.0	4.0	0.8%
25	BURKE/NINE MILE	State	x	993	783	23.7%	3.6	3.4	4.6%
26	BURKE/NINE MILE	State	x	815	591	31.9%	5.3	4.4	17.6%
27	BURKE/NINE MILE	State	x	808	665	19.4%	3.7	3.7	1.1%
28	BURKE/NINE MILE	State	x	34	29	14.4%		0.5	
29	OSBURN	State	x	488	372	27.0%	3.6	3.3	7.6%
30	OSBURN	State	x	533	408	26.5%	7.9	7.4	7.0%
31	OSBURN	State	x	510	404	23.3%	4.7	4.7	0.0%
32	OSBURN	State	x	12884	10900	16.7%	10.8	10.1	6.7%
33	OSBURN	State	x	450	355	23.7%	6.4	6.0	5.7%
34	OSBURN	State	x	315	256	20.7%	3.9	3.7	4.2%
35	SIDE GULCHES	State		492	498	1.2%	7.2	8.1	11.4%
36	SIDE GULCHES	State		215	226	5.2%	4.0	4.3	7.7%
37	SIDE GULCHES	State		25	28	9.8%	0.4	0.6	52.6%
38	SIDE GULCHES	State		284	307	7.7%	2.1	2.4	12.9%
39	SIDE GULCHES	State		3356	3150	6.3%	14.6	15.0	2.7%
40	SIDE GULCHES	State		1058	936	12.2%	13.7	14.6	6.4%
41	SILVERTON	State		528	528	0.1%	3.6	3.9	8.8%
42	SILVERTON	State		316	325	2.8%	3.7	3.9	4.5%
43	SILVERTON	State		616	591	4.2%	3.6	4.1	14.1%
44	SILVERTON	State		115	117	1.6%	1.7	1.8	8.1%
45	SILVERTON	State		755	750	0.7%	3.7	3.7	1.4%
46	SILVERTON	State		142	154	8.0%	1.2	1.4	14.6%
47	SILVERTON	State	x	656	546	18.4%	6.6	6.6	0.2%
48	SILVERTON	State		1724	1560	10.0%	11.6	11.9	2.6%
49	SILVERTON	State		747	679	9.5%	7.8	7.8	0.4%
50	SILVERTON	State	x	262	217	18.8%	3.4	3.1	8.0%
51	SILVERTON	State		217	219	1.0%	2.7	2.8	5.5%
52	SILVERTON	State		432	383	12.0%	3.6	3.8	6.2%
53	SILVERTON	State		196	221	12.2%	2.8	3.3	16.0%
54	SILVERTON	State		231	247	6.5%	3.6	3.9	7.7%
55	SILVERTON	State		424	455	7.0%	3.1	3.5	13.4%
56	BURKE/NINE MILE	State	x	765	623	20.4%	4.0	4.1	2.0%
57	LOWER BASIN/CATALDO	State	9&11	1337	1180	12.5%	5.5	6.0	8.2%
58	LOWER BASIN/CATALDO	State	2&1	1231	1000	20.7%	7.1	6.9	3.4%
59	LOWER BASIN/CATALDO	State	21&57	34	34	0.6%	0.4	0.7	66.7%
60	LOWER BASIN/CATALDO	State	10&34	6084	5290	14.0%	10.3	9.6	7.0%
61	LOWER BASIN/CATALDO	State	16&86	51	45	12.1%	0.7	0.8	7.8%
62	LOWER BASIN/CATALDO	State	13&119	285	240	17.0%	1.3	1.4	7.4%
63	LOWER BASIN/CATALDO	State	4&127	269	463	53.0%	1.0	2.2	75.0%
64	LOWER BASIN/CATALDO	State	17&135	26	14	59.0%		0.5	
65	LOWER BASIN/CATALDO	State	19&139	184	151	19.5%	2.6	2.2	15.1%
66	KINGSTON	CLP		572	493	14.8%	4.6	4.1	10.4%
67	KINGSTON	CLP		24	21	14.7%	0.3	0.1	115.8%
68	LOWER BASIN/CATALDO	CLP		178	189	6.1%	1.3	1.0	29.1%
69	KINGSTON	CLP		379	343	9.9%	2.3	2.5	6.6%
70	KINGSTON	CLP		1356	1260	7.3%	3.2	3.0	5.2%
71	KINGSTON	CLP		71	71	0.4%	0.5	0.5	6.2%
72	KINGSTON	CLP		226	208	8.2%	1.6	1.3	19.4%
73	KINGSTON	CLP		111	108	2.4%	0.9	0.8	17.1%
74	LOWER BASIN/CATALDO	CLP		58	333	141.0%	1.0	14.7	175.0%
75	LOWER BASIN/CATALDO	CLP		1407	1280	9.5%	6.9	6.4	7.7%
76	LOWER BASIN/CATALDO	CLP		30	31	3.7%	0.3	0.1	85.7%
77	SIDE GULCHES	CLP		84	73	14.2%	2.3	2.0	14.4%
78	SIDE GULCHES	CLP		430	353	19.6%	5.6	4.7	17.1%
79	SIDE GULCHES	CLP		545	477	13.3%	6.3	6.4	1.6%
80	SIDE GULCHES	CLP		100	93	8.2%	2.5	2.3	8.7%
81	SIDE GULCHES	CLP		811	1030	23.7%	2.2	6.2	97.0%
82	SIDE GULCHES	CLP		417	372	11.5%	7.7	7.4	3.8%
83	SIDE GULCHES	CLP		3920	3300	17.2%	11.7	11.0	6.2%
84	SIDE GULCHES	CLP		96	89	7.7%	2.3	2.1	9.5%

Table 8 Comparisons between Original IDHW/ATSDR and Reanalyzed Archived Sample Results (continued)

Result	Sub-Area	Laboratory	Common Homes	Lead IDHW/ATSDR 1996 Results	Lead Archive Sample Reanalysis	Lead Relative Percent Difference	Cadmium IDHW/ATSDR 1996 Results	Cadmium Archive Sample Reanalysis	Cadmium Relative Percent Difference
85	SIDE GULCHES	CLP		179	160	11.0%	2.1	1.7	19.1%
86	SIDE GULCHES	CLP		801	744	7.4%	8.6	8.6	0.0%
87	SIDE GULCHES	CLP		414	402	2.8%	5.1	5.7	11.1%
88	SIDE GULCHES	CLP		930	863	7.4%	8.2	8.1	1.1%
89	SIDE GULCHES	CLP		509	466	8.9%	6.1	5.9	3.3%
Combined	Arithmetic Mean			835	746	13.9%	4.2	4.3	16.0%
	Geometric Mean			341	320		2.9	2.9	
	Minimum			24	14		0.3	0.1	
	Maximum			12884	10900		14.6	15.0	
	p Value (Geometric Mean)			0.7034			0.7972		
	p Value (Arithmetic Mean)			0.7533			0.9990		

Table 9 Comparison of IDHW/ATSDR and USEPA by Geographic Sub-Area

		N		Arithmetic Means			Geometric Mean		
Area/Subarea	Chemical of Concern	USEPA	ARCHIVE	USEPA	ARCHIVE	P	USEPA	ARCHIVE	P
Overall Basin	Antimony	120	76	5.7	4.9	0.5714	3.5	2.6	0.0394
	Arsenic	120	76	20.8	18.9	0.4944	17.8	12.8	0.0006
	Cadmium	120	76	5.2	4.2	0.0498	4.1	2.7	0.0014
	Iron	111	76	20428.3	17808.3	0.0117	19705.2	16855.3	0.0002
	Lead	120	76	1085.0	658.1	0.0760	559.8	300.5	0.0004
	Manganese	111	76	996.2	870.8	0.1702	902.2	717.2	0.0019
	Zinc	120	76	646.2	427.0	0.0014	503.3	289.7	0.0001
Mullan	Antimony	9	11	9.6	7.2	0.5214	6.2	5.0	0.6423
	Arsenic	9	11	19.3	14.7	0.3572	16.0	12.6	0.3835
	Cadmium	9	11	4.4	5.4	0.6262	3.6	3.6	0.9510
	Iron	9	11	23226.9	17100.0	0.0662	21886.0	16501.0	0.0651
	Lead	9	11	1567.2	1296.1	0.6921	1116.4	594.4	0.2662
	Manganese	9	11	1483.2	1235.2	0.4692	1311.8	1045.3	0.3982
	Zinc	9	11	810.4	746.2	0.8039	717.6	493.8	0.3314
Burke/Nine Mile	Antimony	26	2	4.4	7.3	0.3488	3.4	7.2	0.1245
	Arsenic	26	2	15.8	11.5	0.4083	14.6	11.5	0.4121
	Cadmium	26	2	5.5	3.8	0.4623	4.4	3.7	0.7767
	Iron	24	2	18875.1	16585.0	0.5905	18117.4	16323.2	0.6274
	Lead	26	2	915.2	703.0	0.7323	639.0	698.4	0.8921
	Manganese	24	2	945.8	718.5	0.4092	881.9	716.2	0.4585
	Zinc	26	2	868.6	414.0	0.2410	724.6	411.0	0.2259
Wallace	Antimony	17	0	10.4	-	-	4.6	-	-
	Arsenic	17	0	19.7	-	-	18.2	-	-
	Cadmium	17	0	6.7	-	-	5.7	-	-
	Iron	16	0	21356	-	-	20846.4	-	-
	Lead	17	0	2109.7	-	-	1144.8	-	-
	Manganese	16	0	967.6	-	-	890.6	-	-
	Zinc	17	0	853.5	-	-	758.1	-	-
Silverton	Antimony	7	13	4.9	3.3	0.5165	2.2	2.2	0.9988
	Arsenic	7	13	12.6	12.2	0.8484	12.1	11.3	0.7066
	Cadmium	7	13	4.1	4.3	0.8571	3.2	3.7	0.6350
	Iron	6	13	18464.2	14925.4	0.0107	18203.0	14802.6	0.0128
	Lead	7	13	1271.8	479.2	0.2068	475.9	376.2	0.6274
	Manganese	6	13	896.6	714.5	0.1987	838.8	675.3	0.2594
	Zinc	7	13	417	389.5	0.8193	351.1	321.4	0.7773
Osburn	Antimony	42	0	4.9	-	-	3.7	-	-
	Arsenic	42	0	23.7	-	-	21.0	-	-
	Cadmium	42	0	5.2	-	-	4.3	-	-
	Iron	39	0	19801.9	-	-	19512.4	-	-
	Lead	42	0	723.7	-	-	421.2	-	-
	Manganese	39	0	955.2	-	-	914.2	-	-
	Zinc	42	0	466	-	-	385.1	-	-
Side Gulches	Antimony	8	18	2.6	6.0	0.1861	2.4	3.3	0.4646
	Arsenic	8	18	21.1	35.1	0.3600	19.5	21.3	0.8015
	Cadmium	8	18	3.7	6.2	0.1273	3.1	4.7	0.2488
	Iron	8	18	21737.3	22553.9	0.8318	21565.2	20979.3	0.8373
	Lead	8	18	324.6	727.8	0.2545	267.5	367.3	0.5169
	Manganese	8	18	865.2	1042.7	0.6022	810.8	824.4	0.9459
	Zinc	8	18	317.6	499.8	0.2241	288.2	377.3	0.3806
Kingston	Antimony	8	16	2.5	2.8	0.7494	2.0	1.9	0.9118
	Arsenic	8	16	14.4	15.6	0.8321	13.9	12.4	0.6448
	Cadmium	8	16	3.9	2.1	0.0318	3.4	1.5	0.0553
	Iron	7	16	17239.8	16227.5	0.4635	17223.2	15901.8	0.3254
	Lead	8	16	385.9	333.2	0.6903	350.1	213.0	0.2115
	Manganese	7	16	631.9	626.9	0.9585	623.5	580.8	0.6734
	Zinc	8	16	406.9	252.1	0.0495	377.2	205.3	0.0296
Lower Basin/Cataldo	Antimony	3	16	7.4	5.4	0.7591	3.5	1.8	0.4605
	Arsenic	3	16	67.8	13.1	0.0013	44.2	8.5	0.0135
	Cadmium	3	16	8.1	3.2	0.1041	2.3	1.6	0.7329
	Iron	2	16	43080	17032.5	0.0084	36834.9	15812.3	0.0120
	Lead	3	16	3817.5	605.6	0.0091	766.8	158.7	0.2152
	Manganese	2	16	2537.4	816.6	0.0632	1307.5	613.6	0.2218
	Zinc	3	16	1622.9	332.7	0.0031	679.4	185.1	0.1273

Table 10
Final Database for Characterizing Metals Concentrations other than Lead by Geographic Sub-area

	Mullan	Burke/ Nine Mile	Wallace	Silverton	Osburn	Side Gulches	Kingston	Lower Basin/ Cataldo
N	20	28	17	20	42	26	24	19
ANTIMONY								
Arithmetic Mean	8.3	4.6	10.4	3.8	4.9	5.0	2.7	5.7
Minimum	1.3	1.1	1.4	0.4	1.3	0.5	0.4	0.5
Maximum	33.2	18.2	91.9	22.8	36.4	28.1	7.8	40.3
Standard Deviation	8.0	4.1	21.8	5.1	5.6	6.1	2.1	9.9
Geometric Mean	5.5	3.6	4.6	2.2	3.7	3.0	2.0	2.0
Geometric Standard Deviation	1.55	1.53	1.70	2.38	1.49	1.93	2.29	3.04
ARSENIC								
Arithmetic Mean	16.8	15.5	19.7	12.3	23.7	30.8	15.2	21.7
Minimum	6.2	7.2	7.3	4.6	9.7	6.2	5.1	2.3
Maximum	42.5	36.9	40.7	17.6	83.2	140.0	66.7	108.0
Standard Deviation	10.9	6.9	8.1	3.9	13.7	35.3	12.2	30.1
Geometric Mean	14.0	14.3	18.2	11.6	21.0	20.7	12.9	11.0
Geometric Standard Deviation	1.23	1.14	1.15	1.16	1.16	1.27	1.21	1.46
CADMIUM								
Arithmetic Mean	4.9	5.3	6.7	4.2	5.2	5.4	2.7	4.0
Minimum	0.5	0.3	1.4	1.0	1.0	0.6	0.1	0.1
Maximum	13.4	12.9	18.8	11.9	19.7	15.0	6.9	14.7
Standard Deviation	4.0	3.1	4.1	2.7	3.5	3.8	1.9	4.7
Geometric Mean	3.6	4.3	5.7	3.5	4.3	4.1	1.9	1.7
Geometric Standard Deviation	1.66	1.51	1.35	1.48	1.45	1.59	2.53	3.91

Table 10
Final Database for Characterizing Metals Concentrations other than Lead by Geographic Sub-area (continued)

	Mullan	Burke/ Nine Mile	Wallace	Silverton	Osburn	Side Gulches	Kingston	Lower Basin/ Cataldo
N	20	28	17	20	42	26	24	19
IRON								
Arithmetic Mean	19857	18699	21356	16043	19802	22303	16536	19927
Minimum	8730	10070	15720	11890	14000	13870	11600	11740
Maximum	43167	36840	37660	23225	36800	52600	24230	65420
Standard Deviation	7470	5625	5326	2962	3764	8775	2961	14022
Geometric Mean	18737	17973	20846	15801	19512	21158	16293	17370
Geometric Standard Deviation	1.03	1.03	1.02	1.02	1.02	1.03	1.02	1.05
LEAD								
Arithmetic Mean	1418	900	2110	757	724	604	351	1113
Minimum	47	64	346	94	110	28	21	14
Maximum	5140	3948	16026	6098	8739	3300	1260	7100
Standard Deviation	1465	823	3703	1315	1360	819	296	2072
Geometric Mean	789	643	1145	408	421	333	251	203
Geometric Standard Deviation	1.18	1.13	1.14	1.17	1.15	1.19	1.16	1.37
MANGANESE								
Arithmetic Mean	1347	928	968	772	955	988	628	1008
Minimum	414	344	510	284	448	408	232	251
Maximum	3159	1946	2278	1326	1819	3600	1090	4712
Standard Deviation	737	365	448	282	288	779	208	1246
Geometric Mean	1158	868	891	723	914	820	593	667
Geometric Standard Deviation	1.08	1.06	1.06	1.06	1.04	1.08	1.06	1.12

Table 10
Final Database for Characterizing Metals Concentrations other than Lead by Geographic Sub-area (continued)

	Mullan	Burke/ Nine Mile	Wallace	Silverton	Osburn	Side Gulches	Kingston	Lower Basin/ Cataldo
N	20	28	17	20	42	26	24	19
ZINC								
Arithmetic Mean	775	836	854	399	466	444	304	536
Minimum	89	205	334	116	131	86	50	35
Maximum	1890	2176	2278	1010	1467	1360	714	2670
Standard Deviation	552	521	472	247	315	347	184	754
Geometric Mean	584	696	758	331	385	347	251	227
Geometric Standard Deviation	1.13	1.10	1.07	1.11	1.10	1.12	1.12	1.25